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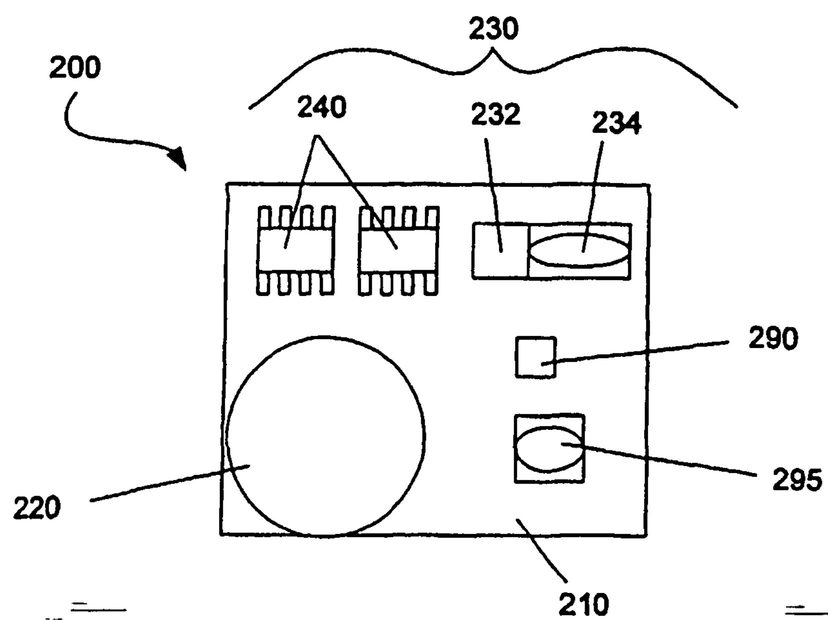

(57) Abstract: A vital sign detection device is disclosed for detecting and communicating the presence of a heart beat, a biological function, or biometric trait of an individual. A communication equipped vital sign detection device allows cheap, efficient monitoring of the vital signs of multiple individuals from a central location. The vital sign detection device may also be relatively small, disposable, and portable, providing valuable monitoring functions in emergency situations.

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VITAL SIGN MONITOR AND METHOD

TECHNICAL FIELD

The present invention relates to the monitoring of vital signs and more particularly to a temporary device for monitoring vital signs such as a heart beat, temperature, respiration, or the like.

BACKGROUND

A person's vital signs, such as heart rate, temperature, respiration, or the like, may be monitored for a number of reasons. For instance, the vital signs of a patient in a hospital are monitored to provide information about the health status of the patient. Emergency responders monitor the vital signs of victims in the field to ascertain health status and perform triage. Athletes monitor their vital signs to improve training techniques and evaluate fitness levels. In short, vital signs may be monitored for any number of reasons.

Typically, continual vital sign monitoring requires either hands-on human attention or bulky and expensive equipment. For example, emergency personnel responding to an emergency call, such as paramedics, may physically locate the pulse of a patient by placing a finger or fingers on a patient's wrist or carotid artery. Such methods require the paramedic to have at least one free hand to monitor a patient's pulse. Similarly, a pulse may be monitored with a stethoscope, which also requires that a paramedic dedicate their time, energy, and any free hands to monitoring the patient's pulse. Alternatively, a patient's pulse may be monitored using bulky and expensive equipment. However, the availability and use of such equipment in emergency situations, or in those instances where a plurality of subjects must be monitored, is rarely feasible.

Although much of the equipment used in the medical and emergency professions is bulky and unwieldy, miniaturization of vital sign monitors is occurring. The use of heart rate monitors by athletes is a prime example of such miniaturization. Heart rate monitoring devices, such as electronic sensing chest straps, communicate with a wristwatch or other device to display and record the heart rate of the athlete over a period of time. Although such devices are slowly becoming novelty items for the

amateur athlete, their widespread use is lacking. Furthermore, miniaturization of heart rate monitoring devices, or other biometric monitoring devices, has not become widespread, especially in the emergency and medical fields.

There exists a need for a small and reliable method and/or apparatus for monitoring vital signs or biometrics such as the heart beat, respiration rate, body temperature and the like.

DISCLOSURE OF INVENTION

The present invention relates generally to the monitoring of vital signs. More particularly, the present invention relates to a vital sign monitor and method for using the same. The vital sign monitor is temporarily attached to a mammal, such as a human, to monitor vital signs and provide feedback as to the status of the monitored vital signs.

Preferably, the vital sign monitor of the present invention is a temporary device easily deployed on a subject to determine the status of certain vital signs. The vital sign monitor itself is fairly small, having electronic circuitry positioned between a flexible base and a protective cover. The flexible base includes an adhesive for temporarily attaching the vital sign monitor to the skin of the desired subject. It is understood that alternative attachment mechanisms, such as elastic bands, tape, or the like, may be used instead of an adhesive to attach the vital sign monitor to a subject. Flexibility of the base is also desirable because the vital sign monitor preferably conforms to the surface to which it is applied.

The electronic circuitry positioned between the flexible base and the protective cover includes the elements necessary for monitoring, interpreting, and communicating the status of the vital signs monitored by the vital sign monitor. For example, a heart beat monitor includes circuitry for detecting or monitoring the pulse of a subject. This may include an infrared emitter and receiver. An infrared signal transmitted by the emitter is partially absorbed and partially reflected by the subject to which the vital sign monitor is temporarily attached. The receiver detects any reflected infrared light and creates a signal based upon that reflected light. As the heart beats, the receiver detects different levels of reflected light based on the variations in the absorption and reflection of infrared light during a heart beat. Based upon the variations in the detected light, the

pulse or heart beat is transformed into a signal. On each beat of the subject's heart, the receiver sends a signal which is translated by the circuitry into an audible signal, visual signal, or both. An audible signal may be a sound emanating from a sound device incorporated into the vital sign monitor or other produced sound. Similarly, the visual signal may be a light flash from a light-emitting diode or the display of a number or symbol on a graphical or digital display. In a preferred embodiment of the present invention, the electronic circuitry for monitoring a heart beat includes circuitry for monitoring the rising edge of a heartbeat.

Additional vital signs, such as body temperature, respiration, pulse oximetry, or the like, can also be detected with additional circuitry and communicated in a similar fashion. Furthermore, the vital sign monitor may be equipped with transmission capabilities, such as radio frequency transmission capabilities, so that multiple vital sign monitors may be monitored from a single location receiving the transmissions.

A power source, such as a battery, provides the necessary power to the vital sign monitor during operation. Typically, the life of the vital sign monitor is dependant upon its power supply. The vital sign monitor, therefore, may include a switch or a trigger which allows the vital sign monitor to be turned on or off. For example, where a battery is used, a nonconductive strip placed between the battery and the electronic circuitry is removed to initiate the flow of current from the battery to the circuitry of the vital sign monitor. A spring switch is used in another embodiment, where initial pressure on the spring connects the battery to the circuitry of the vital sign monitor. In still other embodiments, alternate power sources are used. For instance, a vital sign monitor may include an integrated contact allowing the vital sign monitor to operate off of the body temperature of the subject. In such an instance, the operational life of the vital sign monitor is limited by the amount of time in which the vital sign monitor is attached to the subject or by the temperature of the subject.

If a cover is used with a vital sign monitor, it protects the circuitry of the vital sign monitor and provides support to the device. A cover is preferably at least water resistant as it is foreseeable that the vital sign monitor will be used in situations where bodily fluids or water are present.

The small size of the vital sign monitor offers many advantages over the methods currently used to monitor vital signs. For example, the heart beat monitor

described herein provides an operator, such as a paramedic, a small, reliable device for monitoring the heart beat of a patient while freeing the paramedic's hands to perform other tasks. The audible and visual communications keep the paramedic informed of the patient's heart beats while other tasks are performed. Furthermore, the vital sign monitor is relatively inexpensive and disposable, making an ideal device for use in emergent situations or where numerous individuals must be monitored.

BRIEF DESCRIPTION OF DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming that which is regarded as the present invention, this invention can be more readily ascertained from the following description of the invention when read in conjunction with the accompanying drawings in which:

FIG. 1 is a plan view of the adhesive base of one embodiment of the vital sign monitor of the present invention;

FIG. 2 is a side view of the adhesive base of one embodiment of the vital sign monitor of the present invention;

FIG. 3 is an illustration of one embodiment of the electronics module of the present invention;

FIG. 4 is an illustration of an alternate embodiment of the electronics module of the present invention;

FIG. 5 is an illustration of a vital sign monitor of the present invention; and

FIG. 6 is a circuitry diagram of a heart beat detection circuit incorporated in one embodiment of the present invention.

BEST MODE(S) FOR CARRYING OUT THE INVENTION

The present invention involves an apparatus and methods for monitoring the vital signs of a subject. In more specific terms, the present invention involves a temporary vital sign monitor, or biosensor, for use in monitoring the vital signs or various biometric traits of a mammal. In a preferred embodiment, a small, disposable patch includes circuitry to monitor at least one vital sign, such as the heart beat, of a subject.

One embodiment of the present invention is illustrated in FIG. 5. The vital sign monitor 100 illustrated comprises an electronics module 200 positioned between an adhesive base 110 and a cover 120. The shape and form of the vital sign monitor 100 are illustrative only and it is understood that additional physical configurations for the vital sign monitor 100 are encompassed by the present invention. The vital sign monitor 100 is adapted to temporarily attach to a mammal, or more specifically a human, to monitor specific vital signs of the subject to which it is temporarily attached. Although the vital sign monitor 100 can be used on any mammal, it will be described herein with respect to its use with humans.

The components of one embodiment of the vital sign monitor 100 of the present invention are illustrated in FIGS. 1 through 6. Illustrated in FIG. 1 is a top view of one embodiment of the adhesive base 110 of the vital sign monitor 100. The adhesive base 110 comprises at least an adhesive material sufficient to attach the vital sign monitor 100 to a mammalian surface, such as skin, during the operation of the vital sign monitor 100. The adhesive base 110 also allows easy removal of the vital sign monitor 100 after use. For example, a medical adhesive tape capable of maintaining adhesion to the skin of a subject during physical exertion or in the presence of bodily fluids, such as blood, is desirable.

Alternatively, the adhesive base 110 may be constructed of a flexible substrate 116, such as paper, plastic, or the like, having an adhesive coating 118 on at least one side of the substrate for temporarily securing a vital sign monitor 100 to a subject. A side view of such an embodiment is illustrated in FIG. 2. The adhesive base 110 may also include one or more windows or holes. A window or hole provides a passage through which light, or other energy, may pass. The embodiments illustrated in FIGS. 1 and 2 include both a first window 112 and a second window 114. Adhesive 118 on the adhesive base 110 is preferably covered by a removable film (not shown) that protects the adhesive prior to use of the vital sign monitor 100.

In alternate embodiments of the present invention, the vital sign monitor 100 may be temporarily secured to a subject using something other than an adhesive. For example, a fabric strap may be used to temporarily secure the vital sign monitor 100 to a subject. Tape, elastic products, or other fastening devices may also be used.

Referring to FIG. 3, a representative embodiment of the electronics module 200 of the vital sign monitor 100 is illustrated. The electronics module 200 may include one or more power sources, one or more vital sign detectors and the necessary circuitry to perform the desired functions of the vital sign monitor 100.

The components of the electronics module 200 are preferably mounted on a flex circuit 210. A flex circuit 210 is a thin, lightweight substrate having engineered circuit features. The flex circuit 210 provides flexibility and pliability to the vital sign monitor 100, enabling the vital sign monitor 100 to conform to the contours of the surface to which it is attached. The flex circuit 210 also provides circuitry to connect the various components of the electronics module 200. It is foreseeable that, as circuit design is miniaturized, many of the necessary circuits for the present invention could be incorporated into circuitry design of a flex circuit 210, thereby eliminating the need for additional circuitry components.

The power source 220 for the electronics module 200 may be a battery. The power source 220 is typically in operable communication with the flex circuit 210 circuitry. The power source 220 supplies the necessary or required power to the flex circuit 210 or any circuitry mounted thereon. Ideally, the power source 220 provides enough power to the vital sign monitor 100 to last as long as the vital sign monitor 100 is needed. Typically, a battery having enough charge to provide about two hours or more of vital sign monitor 100 operation is preferred. Of course, the required life of a vital sign monitor 100 may vary with the use to which the vital sign monitor 100 is being employed. Therefore, it is understood that the power source 220, in this case the battery, may be designed to provide a longer or shorter life to the vital sign monitor 100 as desired. It is also understood that a battery is not the only power source which may be used to power the vital sign monitor 100. Alternative power sources 220, such as body temperature or heat, chemical reactions, solar power or other power sources may also be incorporated to power the electronics module 200. Combinations of power sources 220, such as the use of body temperature with battery backup, are also feasible.

The operational life span of the vital sign monitor 100 necessarily depends upon the amount and duration of power supplied to the vital sign monitor 100 by the power source 220. Therefore, the power source 220 is typically activated before power is distributed to the vital sign monitor 100. For example, if a battery is used as the power

source 220, a nonconductive strip, such as a plastic strip (not shown) may separate the power source 220 from the circuitry on the flex circuit. To use the vital sign monitor 100, the nonconductive strip is removed thereby connecting the circuitry with the power source 220 and initiating operation of the device. If body temperature acts as the power source 220, the vital sign monitor 100 would "turn on" upon contact with a surface emanating enough heat to operate the device. Similarly, use of a chemical reaction as the power source 220 is initiated by providing enough force to a particular point of the vital sign monitor 100 to activate a chemical reaction between one or more chemicals to create power. For example, FIG. 4 illustrates a power source 222 having a first bladder 224 or compartment and a second bladder 225 or compartment. Exertion of a force on the first bladder 224 and second bladder 225 causes each bladder to rupture, thereby mixing the contents of the first bladder 224 and second bladder 225. Thus, a first chemical stored in the first bladder 224 and a second chemical stored in the second bladder 225 may be mixed to generate a chemical reaction sufficient to power the vital sign monitor 100.

One or more vital sign detectors 230 may be used with the present invention. A vital sign detector 230 may be operably connected to the flex circuit 210. A heart beat vital sign detector 230 used with the present invention typically comprises an emitter 232, a receiver 234, and a circuit chip 240. These components are used in combination to detect a heart beat of a subject. Although the vital sign detector 230 in the illustrated embodiment monitors the heart beat of a subject, it is understood that substitute, or additional, vital sign detectors 230 can be integrated with the vital sign monitor 100 to monitor additional or alternative vital signs or biometrics, such as temperature, respiration, pulse oximetry, and the like.

The emitter 232, emits energy, preferably in the form of infrared light. An infrared light-emitting diode (LED) is suitable for use as the emitter 232. In another embodiment, an infrared laser, such as a VIXEL, is suitable for use as the emitter 232. The energy emitted from the emitter 232 exits the vital sign monitor 100 through one or more windows 112 in an adhesive base 110. The light or energy emitted by the emitter 232 is partially absorbed and partially reflected by the subject to which the vital sign monitor 100 is attached. Reflected light or energy is detected by the receiver 234 through a second window 114 in the adhesive base 110. The emitter 232 and the

receiver 234 are connected to the vital sign monitor 100 circuitry, where the amount of light that is absorbed or reflected is measured in order to determine whether or not the subject has a heart beat.

The vital sign detector 230 may be operably connected to the necessary circuitry required to monitor the desired vital signs and communicate any information obtained or calculated to the user of the vital sign monitor 100 or others. For example, the emitter 232 and receiver 234 of the vital sign detector 230 can be connected to one or more circuit chips 240 having the necessary electronic components to determine a heart beat of a subject based upon the amount of light absorbed or reflected by the subject. One or more circuit chips 240 translate the information received from the emitter 232 and receiver 234 and then communicate the information in some manner.

For example, the electronics module 200 may also include a LED 290 and a sound device 295 in operable connection with the circuit chip 240. The circuit chip 240 converts the information or data received from the emitter 232 and receiver 234 into signals which cause the LED 290 to flash or the sound device 295 to make a noise. In other words, as the amount of reflected light or energy emitted from the emitter 232 is detected by the receiver 234, a pulse signal is communicated by the LED 290 or sound device 295. The receiver 234 sends a signal corresponding to the amount of light reflected to the circuit chip 240. Based upon the information received, the circuit chip 240 communicates a signal to the LED 290 to flash and/or the sound device 295 to make a sound. In this manner, a heart beat is indicated by the flashing LED 290 and/or the noise emanating from the sound device 295.

Referring to FIG. 6, an example of one possible detector circuit used with the present invention to detect the heart beat of a subject is illustrated. It is understood that other circuit designs for detecting heart beats may also be used and are encompassed by the present invention. The circuit 400 comprises a series of components, including an emitter 232, a receiver 234, a visual output 401, and an audible output 402.

The circuit 400 is controlled by microcontroller 410 powered by a power source 220. Two alternative circuitry designs for the emitter 232 are also illustrated. The first emitter circuit consists of a series of resistors 420 which make up a pseudo-digital to analog converter connected to an infrared LED 480. The resistors have a two-to-one relationship, allowing the microcontroller 410 to control the amount of current

passed to the infrared LED 480. In this manner, the output of the infrared LED 480 is controlled. For example, use of a 180 ohm resistor 422, a 330 ohm resistor 424, a 680 ohm resistor 426 and a 1.2 k ohm resistor 428 for the series of resistors 420 allows the microcontroller 410 to provide from 2 to 40 milliamps of current to the infrared LED 480 if the microcontroller 410 is powered by a 5 volt power source. The current to the infrared LED 480 is varied depending upon the operational requirements which are determined by the voltage comparison circuitry 470 described herein.

In the alternative, a pulse width modulation (PWM) output circuit 430 is used to provide a pulsed light source for the emitter 232. The microcontroller 410 applies a voltage to the emitter follower circuit 432. The voltage applied is proportional to the duty cycle, or pulse width, emitted from the microcontroller 410 and set by resistor 436 and capacitor 438. In the illustrated example, resistor 436 is a 1 ohm resistor and capacitor 438 is a 0.1 uF capacitor. Up to 256 different voltage values can be applied to the emitter follower circuit 432 using the resistor 436 and capacitor 438 combination illustrated. Capacitor 439 provides a high current reservoir which can be dumped into an infrared LED or a laser diode 434 to pulse an infrared LED or cause the laser diode 434 to lase. The PNP switch 433 is controlled by the microcontroller 410 to assure that capacitor 439 is charged to provide the necessary current to the infrared LED or the laser diode 434. The laser diode 434 used with the illustrated circuit is a VIXEL, although other laser diodes, lasers, or LEDs could be used with the PWM output circuit.

Microcontroller 410 also controls the receiver 234 which comprises a photo transistor 440 and associated circuitry for detecting the heart beat of a subject from the light reflected by the subject. The photo transistor 440 senses reflected light from the subject and translates the amount of detected light into a voltage, usually on the order of a few millivolts. The voltage is passed through a first amplifier 442 which provides a low amplitude direct current. A second amplifier 444 boosts the voltage received from the first amplifier 442 by about ten fold. The signal from the second amplifier 444 is passed to an emitter follower base band detector 446. The emitter follower base band detector 446, in combination with resistor 447 and capacitor 448, provide a baseband demodulization of the signal. In the illustrated example, the resistor 447 is a 27 K ohm resistor and the capacitor 448 is a 22 uF capacitor. A second

capacitor 449 (15 uF in this example) acts as an alternating current coupling capacitor by removing the DC component of the signal. An output amplifier consisting of an amplifier 450 and two resistors (451 and 452) provides the final signal to the microcontroller 410. The resistors provide a signal gain across the amplifier. In the illustrated embodiment, the gain is approximately 1000 using a 10 k ohm resistor 451 and a 10 mega ohm resistor 452. The output of the amplifier is directed to the microcontroller 410. If a signal is detected by the microcontroller 410, a visual signal and/or an audible signal are triggered.

The gain of the circuit 400 may be altered in other fashions as known in the art to ensure that a signal, adequate to operate the vital sign monitor 100, is sent and received. In addition, adjustment of the gain of the circuit 400 for specific uses may help improve the resolution of the signals received by the vital sign monitor 100.

An additional amplifier 456 provides low pass filtering to the circuit. The amplifier 456 receives the same signal as the output amplifier 450, however, an additional capacitor 457 (47 uF in this example) is placed across the amplifier's 456 feedback path. When passed through a 10 mega ohm resistor 458 to the negative input of the output amplifier 450, the low frequencies below those created by a heart beat are canceled. This allows the output amplifier 450 to have a greater dynamic range for detecting a heart rate. Other filtering circuits may also be incorporated with the circuit 400 to provide increased resolution and operational stability.

A visual signal circuit and an audio signal circuit are also operably connected to the microcontroller 410. When the microcontroller 410 receives a signal from the output amplifier 450 of the receiver 234, both a visual signal and an audio signal are triggered. In the illustrated embodiment, the visual signal consists entirely of a LED 401. On each heart beat, the receiver 234 receives a certain amount of reflected light which forms the signal which triggers the microcontroller 410 to flash the LED 401. Thus, the LED 401 flashes with each detected heart beat. Similarly, on each signal from the output amplifier 450, an audible signal is also created. The microcontroller 410 sends a signal to an audio device 402, which converts the signal into a sound that audibly indicates the presence of a heart beat.

Although the visual signal illustrated in FIG. 6 is a LED 401, it is also understood that additional visual signals could be incorporated with the device. For

example, a digital readout could display the number of heart beats which have occurred, the number of heart beats per minute, or other desirable data programmed or hardwired into the microcontroller 410 or vital sign monitor 100. It is also understood that additional embodiments include switches allowing a user to turn either one, or both, of the visual or audible alarms off, as desired.

A voltage comparison circuit 470 provides information about the intensity of the emitter 232 signal to the microcontroller 410. This information is used to adjust the voltage levels applied to the infrared LED 480 or laser diode 434 of the emitter 232. The voltage calculated from the light sensed by the receiver 234 is compared with the desired operational parameters which are set by resistors 272, 273, 274, and 275 (47, 47, 100, and 82 k ohms respectively). The resistors, in combination with comparators 276 and 278 create an operational window within which optimal operation of the vital sign monitor 100 occurs. An upper threshold and a lower threshold are established. If the voltage received from the receiver 234 falls outside of the operational window voltage, the microcontroller 410 adjusts the voltage applied to the infrared LED 480 or laser diode 434. If the voltage from the receiver 234 is above the operational window, the voltage to the emitter 232 is lowered. If the voltage from the receiver 234 is lower than that desired, the voltage to the emitter 232 is increased by the microcontroller 410. In this fashion, the intensity or brightness of the infrared LED 480 or laser diode 434 is lowered or raised, respectively. Thus, the voltage comparison circuit 470 provides a reference by which the microcontroller 410 controls the voltage to the emitter 232 based upon the signal received by the receiver 234.

It is understood that the circuit described herein is only one example of the type of circuit which may be integrated with the present invention. Other circuits, or combinations of circuits, for monitoring vital signs can just as easily be integrated onto the electronics module 200 of the present invention to provide the desired vital sign monitoring capabilities.

A cover 300 placed over the electronics module 200 may be connected to the adhesive base 110 to complete the vital sign monitor 100. As illustrated in FIG. 5, the electronics module 200 may be positioned between the adhesive base 110 and the cover 300, thereby forming the vital sign monitor 100. The cover 300 is preferably

made of a water resistant material which allows use of the vital sign monitor 100 in situations where body fluids, water, or other fluids may be present.

While the circuitry described with reference to FIG. 6 is quite detailed and technical, the operation of a vital sign monitor 100 employing such circuitry is relatively simple. A vital sign monitor 100, such as that illustrated in FIG. 5, including the circuitry illustrated in FIG. 6, is easy to use. An operator, such as a paramedic, activates the power supply 220 of the vital sign monitor 100 such as by removing a nonconductive strip from the vital sign monitor 100. Activation of the power supply occurs either before or after the vital sign monitor 100 is applied to the skin of the subject. Upon activation, the emitter 232 begins pulsing either an infrared LED 480 or a laser diode 434 depending upon the emission signal being employed with the vital sign monitor 100. For the purposes of this example, it will be assumed that the emitter 232 pulses an infrared LED 480. The photodetector 440 senses the infrared light reflected from the subject and adjusts the intensity of the infrared LED 480 signal based upon the infrared light detected and the output of the voltage comparator circuit 470. Once the vital sign monitor 100 is operating within the desired detection parameters, the heart beat detection begins. The time required for the circuitry of the vital sign monitor 100 to adjust to operational conditions is minuscule and occurs almost instantaneously.

Operating within the desired parameters, the vital sign monitor 100 pulses the LED 480 of the emitter 232 and detects any reflected light from the subject through the phototransistor 440 of the receiver 234. With each heart beat, a greater amount of emitted infrared light is absorbed by the subject than when the heart is not beating. The difference in the amount of reflected light detected by the receiver 234 thereby creates a signal that is translated into the audible and visual signals given off by the vital sign monitor 100. Generally, the rising edge of a heart beat is detected and translated into the vital sign monitor signal 100. With each heart beat, the LED 401 flashes and the audio device 402 beeps or makes some other audible sound. Therefore, as long as the subjects heart is beating, the vital sign monitor 100 attached to a subject provides both audible and visual indications of the heart beat.

The audible and visual signals provided by the vital sign monitor 100 provide a tremendous advantage to the operator using the device. For instance, a paramedic

using a vital sign monitor 100 activates the device and attaches it to the skin of a subject. Almost instantaneously, the vital sign monitor 100 begins to produce audible and visual signals which correspond to the heart beat of the subject. The signals emitted by the vital sign monitor 100 allow the paramedic to audibly or visually monitor the subject's heart rate, thereby freeing the paramedic's hands to perform other tasks.

The vital sign monitor 100 is also a valuable tool for detecting faint heart beats in partially severed limbs or constricted areas. For instance, it is often difficult to determine whether or not a partially severed appendage, such as a leg, is receiving blood. Because the vital sign monitor 100 is capable of detecting blood flowing through veins and arteries, it can be placed on the partially severed appendage to determine if a blood is still flowing to the appendage. As with the example described above, use of the vital sign monitor 100 also allows the operator to use their hands for other tasks.

In another embodiment, the vital sign monitor 100 is equipped with a radio frequency transmitter (not shown). The radio frequency transmitter (RF transmitter) is capable of transmitting the status of the subject's vital signs to a central location. For example, the vital signs of firefighters equipped with a vital sign monitors 100 having RF transmission capabilities are monitored during a fire from a central location. The vital sign monitors 100 of each firefighter transmit the firefighter's vital signs to a computer. This allows the monitoring and detection of any irregularities in the vital signs of the firefighters while they perform their duties. Furthermore, the vital sign monitor 100 may be used to monitor the location or position of the firefighter. Such monitoring can be used to improve the safety of the individuals using the vital sign monitors 100. A radio-frequency equipped vital sign monitor 100 can similarly be used with hazardous waste cleaning crews, military personnel, or in any field where vital sign monitoring is important to the welfare of the individuals participating in the activities.

The use of the vital sign monitor 100, and variations thereof, are not limited to the uses described herein. Instead, it is understood that the vital sign monitor 100 of the present invention has many uses which include medical uses, athletic uses, monitoring uses, hazardous duty uses, military uses, and the like. Although the embodiment of the

vital sign monitor described herein particularly details a heart beat monitor or detector, it is understood that the incorporation of additional vital sign sensors is feasible. For example, the surface temperature of the body may be detected and displayed on a digital output incorporated with the vital sign monitor. Furthermore, pulse oximetry may be determined by incorporating additional circuitry.

Having thus described certain preferred embodiments of the present invention, it is understood that the invention defined by the appended claims is not to be limited by particular details set forth in the above description, as many apparent variations thereof are possible without departing from the spirit or scope thereof as hereinafter claimed.

CLAIMS

What is claimed is:

1. A heart beat detection device, comprising:

a flexible base;

a flex circuit;

a heart beat detection circuit operably mounted to said flex circuit;

a heart beat communication circuit operably mounted to said flex circuit;

a power source in operable communication with said flex circuit to provide an electrical current to said flex circuit, said heart beat detection circuit, and said heart beat communication circuit; and

a cover connected to said flexible base to position said flex circuit, said heart beat detection circuit, said heart beat communication circuit and said power source between said flexible base and said cover.

2. The device of claim 1, wherein said flexible base further comprises:

a flexible substrate having a first side and a second side, wherein said cover is connected to said second side of said flexible substrate; and

an adhesive substantially coating said first side of said flexible substrate.

3. The device of claim 2, further comprising a protective film substantially covering and removably attached to said adhesive substantially coating said first side of said flexible substrate.

4. The device of claim 1, wherein said heart beat detection circuit further comprises:

a microprocessor;

an infrared emitter operably connected to said microprocessor; and

an infrared detector operably connected to said microprocessor.

5. The device of claim 4, wherein said infrared emitter is a light emitting diode.

6. The device of claim 4, wherein said infrared emitter is an infrared laser.

7. The device of claim 4, wherein said infrared detector is a photoelectric detector.

8. The device of claim 1, wherein said heart beat detection circuit is configured to detect the rising edge of a heart beat.

9. The device of claim 1, wherein said heart beat communication circuit comprises a light emitting diode to emit a light signal on each detected heart beat.

10. The device of claim 1, wherein said heart beat communication circuit comprises a sound emitting device to emit a sound on each detected heart beat.

11. The device of claim 1, wherein said power source is a battery.

12. The device of claim 1, further comprising an activation switch to operably connect said power source to said flex circuit to provide said electrical current to said device.

13. The device of claim 12, wherein said activation switch comprises a removable nonconductive material between said power source and said flex circuit to prevent operation of said power source until said removable nonconductive material is removed from said device.

14. A vital sign detection device, comprising:

a flexible base having at least one window therein;

a cover;

an electronics module positioned between said flexible base and said cover to detect and communicate vital sign information; and

a light emitter and a light receiver positioned within said at least one window of said flexible base, said light emitter and said light receiver in operable communication with said electronics module.

15. The device of claim 14, wherein said electronics module comprises:

a flex circuit;

at least one microprocessor operably connected to said flex circuit;

said light emitter operably connected to said flex circuit to emit pulses of infrared light;

said light receiver operably connected to said flex circuit to detect reflected pulses of infrared light emitted from said light emitter;

a power source operably connected to said flex circuit to provide power to said electronics module; and

a communications circuit operably connected to said flex circuit and in communication with said microprocessor to communicate the detection of a heart beat.

16. A disposable heart beat detector device, comprising:

a power source;

a heart beat detection circuit operably connected to said power source; and

a communication circuit operably connected to said heart beat detection circuit to communicate a detection of a heart beat by said heart beat detection circuit.

17. The device of claim 16, wherein said power source is a battery.

18. The device of claim 16, wherein said power source converts heat into a sufficient amount of electricity to operate said heart beat detection circuit.

19. The device of claim 16, wherein said heart beat detection circuit further comprises:

at least one emitter circuit capable of emitting energy;

at least one detector circuit capable of detecting energy; and

at least one translation circuit capable of determining a physical condition from an amount of energy detected by said detector circuit.

20. The device of claim 16, further comprising:

a flexible base having a first side and an opposing second side; and

a cover connected to said second side of said flexible base;

whereby said power source, said heartbeat detection circuit, and said communication circuit are sandwiched between said flexible base and said cover.

21. The device of claim 20, further comprising an adhesive substantially covering said first side of said flexible base to attach said device to a subject.

22. A disposable vital sign detection device comprising an infrared emitter and an infrared receiver for monitoring a heart beat.

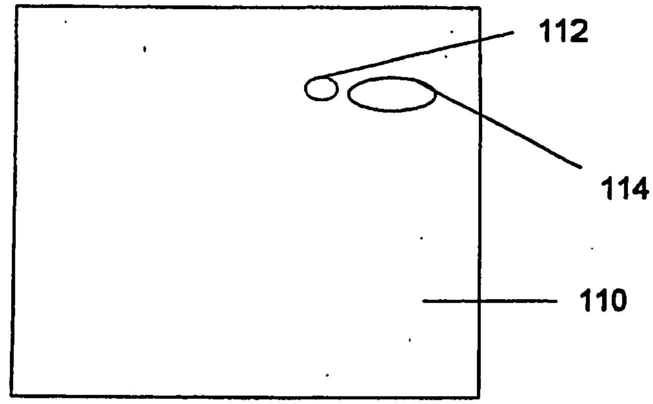


FIG. 1

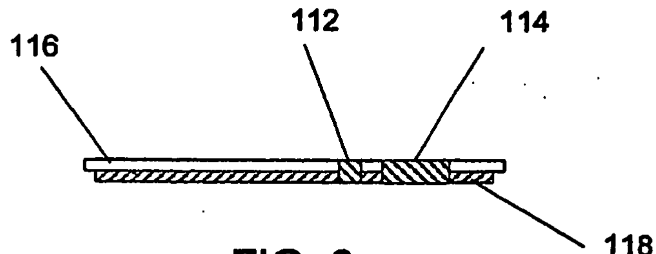


FIG. 2

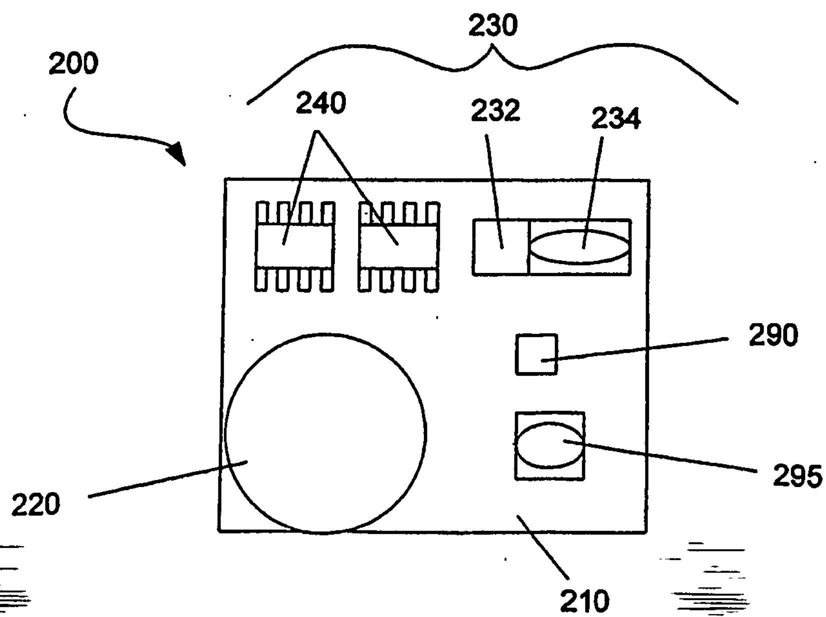


FIG. 3

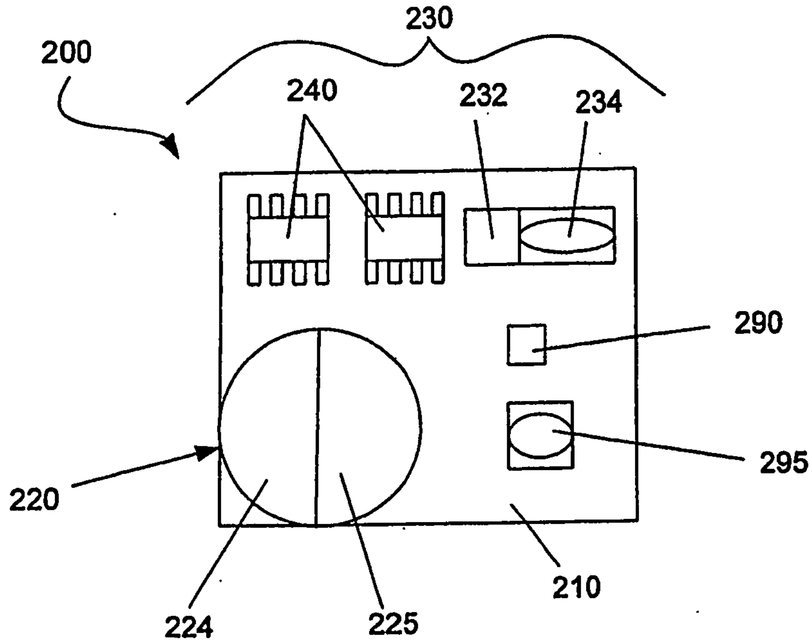


FIG. 4

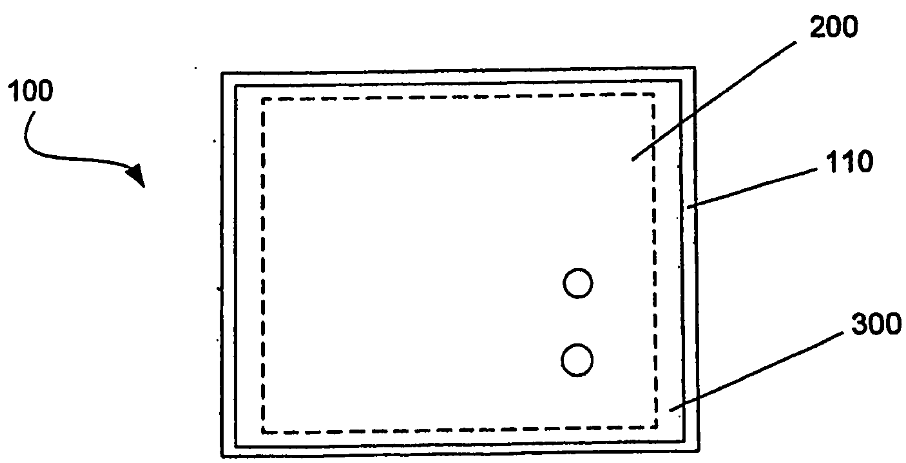
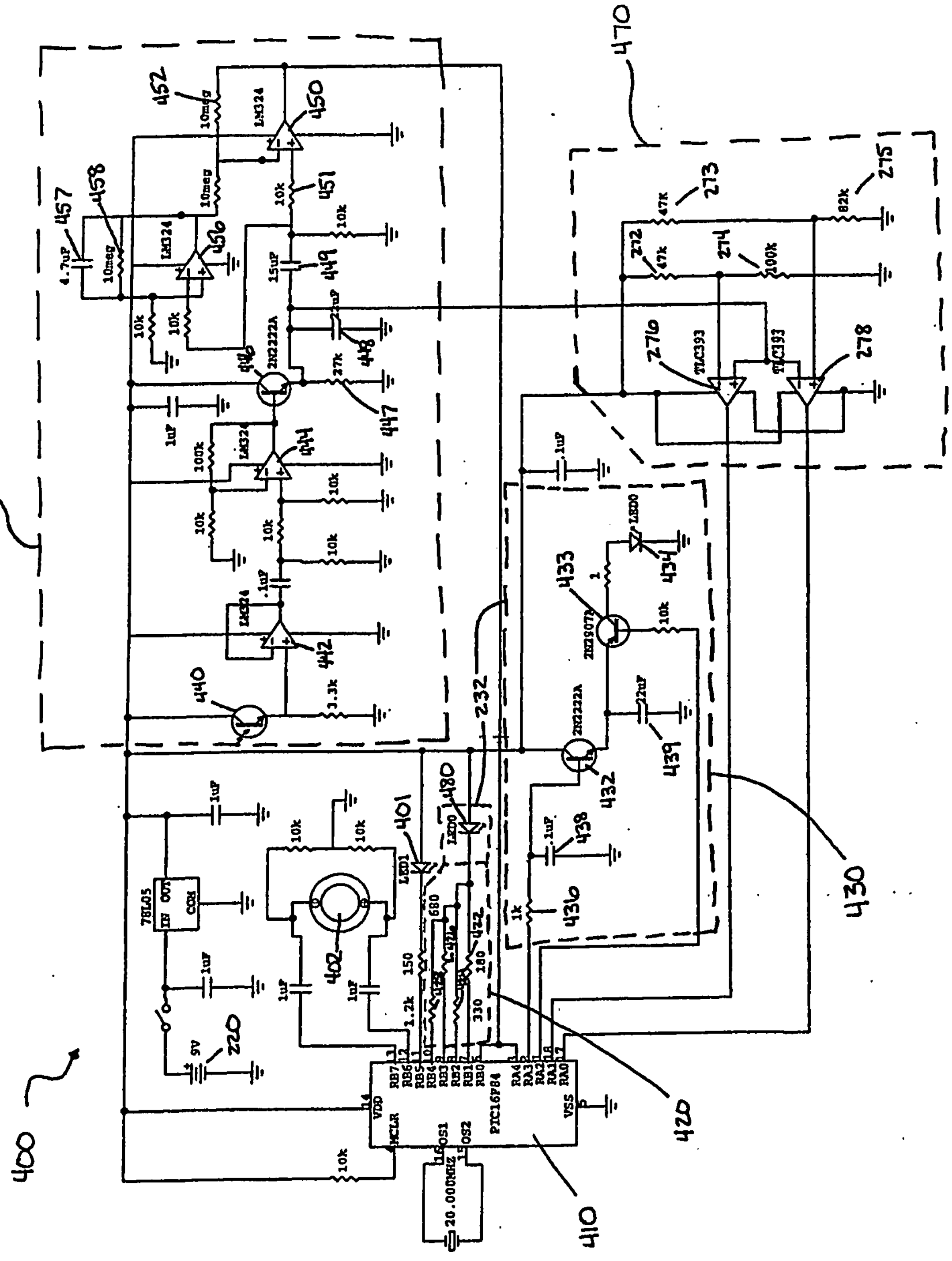


FIG. 5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410
420
430
470
234
232
220
PIC16F84
78L05
2N2222A
2N3907A
LM324
TLC393
20.000MHz
5V

FIG. 6